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have lived to see the time when a very large number of our botanists have brought back to America the best that Europe had to offer. There was a time when our botany might have been said to bear the mark "made in England." In more recent years it may be said to have been "made in Germany." There are some patriotic souls who hope that the time will come, if it has not already come, when we may say "made in America." I do not share their feeling. To me it seems that botany is destined to become more and more widely diffused until it becomes world-wide and it will be enough if we contribute our proper share to the general stock. I have lived to see the growth of several branches of botany which practically were not studied at all when I was young. Bacteriology and cytology are of recent origin. Plant physiology has been with us a child of slow growth, but it frequently has been the case that the strongest men have been slow in their development. Plant pathology from a crude and semi-popular beginning has become an exact science in whose study and practical application we have already surpassed other nations. When this society meets forty years hence, I shall not be present. Few of you will be present. But whatever of progress the speaker on that occasion may be able to report will be the result of a gradual development. It can hardly be expected that he will have to record any such radical and complete transformation as it has been my privilege to present to you this evening.

W. G. FARLOW

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#### THE SIMULIUM-PELLAGRA PROBLEM IN ILLINOIS, U. S. A.<sup>1</sup>

THE advancement of entomology owes much, of recent years, to the stimulus supplied by

<sup>1</sup> Read at the Second International Congress of Entomologists, Oxford, England, August 8, 1912.

the discoveries made by medical men with respect to the agency of insects in the transmission of contagious diseases; and just now our knowledge of the species, distribution, habits, life histories and ecology of *Simulium* is progressing by leaps and bounds in consequence of the well-known *Simulium* theory of the transmission of pellagra, announced by Dr. Louis W. Sambon in 1905, and fully elaborated by him in the *Journal of Tropical Medicine and Hygiene* in 1910.

This stimulus to a study of these insects reached me, in one of the interior states of North America, in August, 1910, when, in consequence of the appointment by the governor of Illinois of a state commission for the investigation of pellagra as occurring in the insane asylums and other institutions of that state, I was requested, as the official entomologist of Illinois, to contribute to their report an account of the distribution of *Simulium*, especially in the neighborhood of state institutions in which cases of pellagra were occurring. As an investigation of all insects injurious or dangerous to the public health in Illinois is one of the prescribed duties of my office, I was bound to avail myself, to the best of my ability, of this opportune call. This I did by detailing an assistant, Mr. C. A. Hart, August 8, 1910, to commence observations and collections along the central part of the course of the Illinois River, and especially to make a careful survey of the vicinity of the general Hospital for the Insane, built upon a bluffy bank of that stream near the city of Peoria. My reason for giving particular attention to this asylum was the fact that it had been the principal seat of pellagra in Illinois, containing in 1909 eighty per cent. of the cases of this disease—that is, one hundred and twenty-seven out of two hundred and twenty—recognized that year in the whole state. This bad preeminence has, in fact, been since maintained, this asylum containing sixty-three per cent. of the four hundred and eight cases known to occur in Illinois during the twenty-six months preceding the first of September, 1911.

In the year 1911 but little could be done on this subject; but beginning with April of the present year a continuous program of observations, collections and breeding-cage studies has been steadily maintained and is still in progress on the Illinois River, and a careful survey has been made of the surroundings of the six insane hospitals of the state, and of the almshouse of the county in which the city of Chicago is situated. Cases of pellagra have occurred in all these institutions during the above-mentioned period, but in widely different ratios to the total number of inmates in each—the Peoria asylum, for example, containing, in 1909, twelve times as many cases per thousand inmates as did any other institution in the state. It thus became a matter of special interest to know the facts in detail concerning the occurrence and abundance of *Simulium* in the immediate neighborhood and in the general vicinity of all these institutions.

Besides this work in the field, the insect collections of my office for many years have been carefully examined, and its field notes and accessions records have been sifted for evidence bearing on the species and distribution of *Simulium* in the state at large; and the whole body of the American literature of the subject has been critically studied, with some reference also to a considerable list of European articles.

According to the present state of our knowledge there are approximately seventy species of *Simulium* on record for the whole world, of which we are known to have but fifteen in the United States of North America. Nine species, or possibly ten—the status of one being uncertain—have been found in Illinois, one of which, *S. hirtipes*, occurs also in Europe. No other European species has been found on the continent of North America, although *S. reptans* is reported from Greenland. The slight attention hitherto paid to these insects in America is illustrated by the fact that two of our nine Illinois species—or three of them, if there are ten in the state—are new to science, descriptions of the two

known to be new being now in press, under the names of *venustoides* and *johannseni*.<sup>2</sup>

As the state of Illinois extends, from north to south, through five and a half degrees of latitude, there is some difference between its most northern and its most southern districts in respect to the predominant species of *Simulium*; but as all have similar habits, and all but one of them are active biters, this fact probably counts for little in the present discussion.

There is some difference also as to the kinds of waters in which the several species prefer to breed, some of them living mainly in the larger rivers, and others occurring only in the smaller streams; but as the state is well watered in all its parts, and is virtually a level plain, there is no part of it which is wholly beyond the reach of some species of *Simulium*. It is true that these insects are rarely seen in some places, and are an annoying nuisance, and indeed a destructive pest in others, especially along the larger rivers in spring; but since we have found them in considerable numbers at a distance of more than five English miles from the nearest water in which they could have bred, and since there is scarcely a small stream anywhere in some part of which *Simulium* larvæ can not be found throughout the spring and summer, even temporary roadside drainage ditches often containing them during the spring season of high water, there must be few people in the state who are not at some time exposed to the attacks of the flies. *Simulium* is, in fact, more completely and uniformly distributed in Illinois than *Anopheles*, and as there is no part of the state wholly and permanently free from malarial disease, there would seem to be no part of it free from danger of pellagra, if this is really transmitted by black-flies.

The contrast is marked between these Illinois conditions and those in Italy, where Samson and his colleagues studied the problem of pellagra and the distribution of the black-fly.

<sup>2</sup> Since printed in a reprint from the 27th Report of the State Entomologist of Illinois, pp. 32 and 42.

There mountain heights, mountain valleys and level plains make up a diversified topography and hydrography, and the distribution of *Simulium* is similarly diversified. It is one of the main lines of Sambon's argument that the distribution of pellagra is limited by the distribution of *Simulium*, although not co-extensive with it. This test can not be verified in Illinois, however, as *Simulium* is generally distributed. Pellagra, on the other hand, is intensely local, so far as is now known; but to this interesting point I shall presently return.

The life histories of the American species of *Simulium* are very imperfectly known, and the same may be said of those of all other parts of the world as well. No species, in fact, has been carefully followed, in its development, around the year, and on only two of our American black-flies, *venustum* and *pictipes*, has any kind of definite life-history work hitherto been done. Probably studies of this sort are now in progress in other places than Illinois, but if so their results have not yet been made known. In our own state we have gone far enough with this phase of our problem to make sure that six of our species, and possibly all of them, produce two or more generations in a season, and that there is a sufficient variation among the different species in respect to the times at which the successive generations emerge, to make it certain that some *Simulium* species may be producing adults at every time of any average year, from early April to late October. We have, in fact, ourselves collected adults of one or more species, and have bred others, in each of these seven months, but much more frequently in April, May and June, than in any later ones.

The actual number of individuals on the wing, indeed, diminishes rapidly after the main spring outburst, so that it is usually difficult to find an adult *Simulium* in August or September, even in places made almost uninhabitable by them in April and May. This may be due in part to unknown features of the life history of two of the most prolific species, *pecuarum* and *meridionale*, but it is certainly due also, at least in part, to summer

shrinkage of the streams and a consequent reduction in the number of suitable places for the breeding of these discriminating insects. Whatever is the explanation, the fact itself is notorious, and it is of especial interest to our inquiry; for if *Simulium* transmits pellagra, there should be, generally speaking, some seasonal correspondence observable between this highly unequal abundance of the insect carriers of the disease and the number of new cases occurring.

There is, indeed, a very notable seasonal periodicity shown in Illinois in respect to the number of new cases of pellagra, but it is not of the kind anticipated by this reasoning. My attention was first called to the facts last December by Dr. H. Douglas Singer, director of the State Psychopathic Institute, at Kankakee. In the Peoria hospital, where the largest number of our new cases have occurred, statistical data were obtainable from July 1, 1909, to September 1, 1911, and the curve showing the frequency of new cases in this hospital presents five notably high points, each the culmination of a wave of increase, in the period of two years and two months which it represents. In the first of these two waves the twenty-one new cases of July are followed by seventy-one in August, and this maximum by thirty-seven, twenty-three, twelve and three for the months of September, October, November and December, respectively. In January, 1910, there was but one new case; in February and March there were none; in April there was one; and with this a new wave started, reaching thirty-four new cases in June, dropping to but four in July, and rising in a second, lower wave of sixteen and fifteen in August and September, respectively, dropping thence to one in October and none at all until February of the following year.

The largest number of new cases occurring in 1911 was only seven, in August, the next largest number coming in May, when there were six, and the two crests of these waves being separated by the low period of June and July, with one and three cases, respectively. In a word, the two annual high points come in either May or June of two of these years,

and in August of three of them; while in the two years for which our records are virtually complete, the first wave is the highest in 1910, and the second is highest in 1911.

I believed at one time that we might make out a relation of succession between these separate waves of increase and the adult periods of successive generations of *Simulium*, but as my data accumulate this relationship becomes decidedly doubtful; and certainly these double pellagra periods can not be connected with any seasonal differences in the abundance of *Simulium*. If there were any causal relation between these two facts there should be but one high pellagra period to correspond with the single spring outrush of *Simulium* adults; or if there were another it should be much lower than the first.

Sambon reports a periodical character different from this observed in Illinois in the fact that it relates to an increased activity of pellagra—an intensification of its symptoms in individual pellagrins—occurring in spring and in fall, coincident, as he says, in Italy with the time of flight of two generations of the sand-flies; and he uses this fact to support his hypothesis of the dependence of the disease on the insects. Assuming that pellagra is produced by a protozoan parasite, he further assumes that the aggravation of symptoms twice each year is due to a migration to the surface of this hypothetical parasite, which is thus exposed to be taken up by the sand-flies as they draw blood from the skin of pellagrins. The summer and fall recrudescences of the disease he thus connects with the summer and fall abundance of the sand-fly imagos. His periods are, however, different from ours, the first coming in March or April instead of May and June, and the second in September or October, instead of August as in Illinois. I have not been able to learn from our physicians that any periodicity similar to this described by Sambon has been noticed in Illinois cases, but if it has it would be impossible to correlate it with the facts above described concerning the development of *Simulium* in our state.

There are other interesting points of con-

trast between our Illinois conditions and conclusions and those obtained by a study of the problem in Italy and in other parts of Europe. We are told, for example, that in Italy pellagra is a rural disease, to which town-dwellers are virtually immune, even where there is free communication between the town and adjacent pellagrous districts; but in Illinois we have every year several deaths from pellagra in our largest city, with a population of more than two million souls. Four cases of this disease have lately been reported to me from the private practise of Dr. Oliver S. Ormsby, secretary of the State Pellagra Commission, the sufferers from which had lived continuously in Chicago for years. Pellagra, in fact, can scarcely be said to be with us, as yet, a rural disease, the asylums in which ninety-six per cent. of the known new cases have occurred being in or very near cities and towns, and all cases reported from outside such institutions having come from the town and not from the country. The Peoria asylum, containing sixty-three per cent. of our known pellagrins, is in a suburb of our second largest city. It draws its patients from all parts of the state, but more than a third of them come from Chicago or its immediate neighborhood. Three other asylums, containing thirty per cent. more of our pellagrins, receive between sixty-three and one hundred per cent. of their inmates from Chicago. The closest relations of these especially pellagrous asylums thus seem to be with our largest cities and not with our rural districts. These facts would be more certainly significant, however, if pellagra had been longer known and more thoroughly studied throughout our territory, and if we had complete and reliable statistics from the state at large.

*Simulium* is said in Italy not to live in towns or to enter houses; but in the town of Havana, a village of thirty-six hundred inhabitants situated on the Illinois River near the central part of my state, it is so great a pest in spring that the people screen their windows to protect themselves from the bites of the black-flies; and we have seen these insects collecting there in great numbers on

the inside surfaces of the window-panes of public rooms, such as the offices of hotels. Furthermore, we have found biting species of *Simulium* breeding and emerging in large numbers, not only in the suburbs and outskirts of Chicago, but far within the limits of that great city—in the Chicago River, which traverses the city, passing through its most densely populated districts, and also in drainage ditches beside the streets when these happen to contain streams of running water for a sufficient time in spring. Indeed, it is not too much to say that *Simulium* may breed in any flowing stream within the city where the water is not offensively foul with sewage and other contaminations.

Reasoning from the time of the onset of pellagra in the case of certain infants born in November and in December, when sand-flies are not abroad in Italy, Dr. Sambon comes to the conclusion that the incubation period in these cases could not have exceeded three weeks, this being the interval to elapse between the time when these infants were first carried out in spring to the fields where they might have been bitten, and the date of the appearance of the rash which was the first symptom of the disease. If this reasoning is sound, and these infantile cases are fair examples of the incubation period of pellagra, then I am troubled to explain the occurrence in Illinois of two asylum cases—both reported as first attacks of the disease—one first manifest on the 24th of December, and the other on the 31st of that month, after a period of three or four weeks of severe cold weather. Our latest Illinois collections of *Simulium* adults made in any year were obtained November 5, and these cases consequently seem to have developed some six or seven weeks after any possibility of infection by means of *Simulium* bites. It is possible, however, that this discrepancy is only apparent, and that these were not new cases, arising in the asylum, but recurrent attacks of a disease originating outside and not previously recognized.

*Simulium* does not require, with us, swift-running streams for its development, some of

the species, at least, breeding in any freely flowing water where the surface is broken into a ripple by depending or projecting objects. A stout weed growing from the bottom of a stream near its margin, or a twig bending down and dipping into the water from the shore, or even a trailing grass blade, will in many cases be thickly covered—but only on the up-stream side—with the larvæ first, and afterward with the pupæ, of *Simulium*. We have even found larvæ and pupæ, both in great abundance, coating objects on the bottom of the river at a distance from the shore and at a depth of nine or ten feet—a point in which our observations differ, so far as I know, from any others on record.

In Italy pellagra is said by Sambon to be essentially a disease of mountain valleys, but if this rule applied in America, we should have only imported cases of pellagra in any part of Illinois or, indeed, within hundreds of miles of its borders. There is, in fact, no common topographic feature distinguishing the three principal seats of pellagra in our state. The Peoria asylum, with two hundred and fifty-eight new cases in twenty-six months, is on a bluff about a hundred and fifty feet in height beside one of our largest rivers; the Elgin asylum, with thirty-eight new cases in the same time, is on a more sloping bank, less than half as high, beside a much smaller stream; and the Dunning almshouse is on a level open plain, with no water in its vicinity except a small drainage ditch, which often goes dry in midsummer. The country surrounding all these hospitals is a level or slightly rolling plain, originally covered with prairie grass except where streams were bordered with narrow belts of forest.

From the foregoing it will be seen that, although in this discussion I have been obliged to take a critical attitude towards the *Simulium* theory of this disease, our Illinois data are not, by themselves, conclusive either for or against that hypothesis. This is a source of regret to me, although scarcely a disappointment, as one entomologist, working for so short a time and in so limited an area, could scarcely expect to bring this time-worn

and complicated problem to the point of actual solution; and I must be content with bringing forward my personal contribution of matters of fact to this important inquiry, of a kind to require that they be taken into account in forming an adequate theory of this disease. In the meantime, whether the *Simulium* theory be finally justified or not, it should be especially welcome to us, as I intimated in the beginning, as giving us motive and opportunity greatly to increase our knowledge of these interesting insects; and it is particularly for this reason that I have ventured to bring this imperfect discussion of a problem yet unsolved before this congress of the entomologists of the world.

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#### *EOANTHROPUS DAWSONI*

A MEMORABLE and crowded meeting of the Geological Society was held in Burlington House, London, on December 18, to hear a paper read "On the Discovery of a Paleolithic Human Skull and Mandible in a Flint-bearing Gravel overlying the Wealden (Hastings Beds) at Piltdown, Fletching (Sussex)," by Charles Dawson, F.S.A., F.G.S., and Arthur Smith Woodward, LL.D., F.R.S., Sec.G.S.

Four years ago Mr. Dawson noticed that a certain road had been recently mended by peculiar flints, which he traced to a shallow pit. A little later he found that the laborers had dug out a "thing like a coco-nut," the fragments of which they threw on a rubbish heap. Mr. Dawson found there a part of a human skull which he showed to Dr. Smith Woodward; they realized the importance of the discovery, but kept it secret until they had time to exhaust the pit. This took a long time, as it is under water for six months in the year. Half of a mandible was found in the undisturbed gravel close to the spot where the skull occurred.

The gravel at Piltdown rests on a plateau 80 feet above the river Ouse and at a distance of less than a mile to the north of the existing stream. Thus denudation to the extent of 80 feet has taken place since the gravel was

formed. In the gravel were found two broken pieces of the molar of a Pliocene type of elephant, a much rolled cusp of a molar of *Mastodon*, besides teeth of *Hippopotamus*, *Castor* and *Equus*, and a fragment of an antler of *Cervus elaphas*; all of which, like the human skull, were well mineralized with oxide of iron. Many water-worn iron-stained flints were obtained which closely resemble the artifacts from the North Downs near Ightham, to which the term "eoliths" is generally applied. A few implements of the characteristic Chellean type also occurred. The gravel is (archeologically) early paleolithic and (geologically) early pleistocene of about the same age as the Norfolk Forest Bed. Professor Sollas places the Chellean industry in the second genial episode of the Ice Age, but the artifacts of Ightham type, and the remains of elephant and mastodon were doubtless derived from an Upper Pliocene deposit.

Although the cranium is very fragmentary, the pieces recovered so abut on one another that an accurate contour of the brain case can be obtained, and a cast could be made of the cavity, which reveals the broad features of the brain. The cranium is typically human, and has a capacity of at least 1,070 c.c. It measures about 190 mm. in length from the glabella to theinion, and 150 mm. in width at the widest part of the parietal region. The bones are remarkably thick, the average thickness being 10 mm. The forehead is prominent and not receding as in the Neanderthal cranium, and the brow ridge is feeble; the occipital bone shows that the tentorium over the cerebellum is on the level of the external occipital protuberance, as in modern man. The temporal muscles extended higher up on the skull than in any recent or fossil man. When viewed from behind it is seen that the cranium is surprisingly broad and low. The mastoid processes are small. There do not appear to be any characters in the cranium which can not be matched severally in various existing human skulls. No facial bones were discovered. The right half of the mandibular ramus is nearly complete to the symphysis and lacks only the articular condyle and the